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BLIS – Brain Lateralisation Information System for Personalised Education Programmes offered to Students of Engineering

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Abstract

In this paper we present an automated analysis system called BLIS- Brain Lateralisation Information System that we applied to students attending Computer Science, Environmental Engineering, Applied Electronics specialities. The Information System that we have designed helps us to analyse the creative potential of our engineering students and their type of thinking. From an educational perspective, we aim at identifying ways in which creative thinking and problem solving techniques can be implemented in existing courses of the engineering curricula, further on to the achievement of personalised Education Programmes for students attending courses in the fields of Engineering.

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Keywords: Information Systems, Personalised Education, Brain lateralisation, Thinking styles, Student empowerment

1. Introduction

Students of Engineering require a balance between certain abilities mainly connected to the left brain side e.g. symbolic and logical thinking, and those of the right brain side, e.g. creativity and problem solving capabilities. According to literature, students require a special pattern of thinking in order to successfully assimilate basic sciences (mathematics, physics, mechanics) and new digitised technological disciplines (computer assisted design, multimedia techniques and technologies, virtual labs, etc.) that require special knowledge and capabilities such as creativity, problem solving.

We carried out a survey that involved applying several questionnaires through a Brain Lateralisation Information System (BLIS).

In this paper we discuss how BLIS facilitates the study of the influence of brain lateralisation on the general capabilities of the students who hear Engineering curricula. BLIS has been tested on 150 students, aged 19-37, and enrolled in Applied Electronics, Computer Sciences and Environmental Engineering programmes. The questionnaires were based on Roger Sperry's theory of brain lateralisation (Sperry, 1974). Data obtained has been

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analysed both quantitatively and qualitatively. In chapter 2 we overview some basic concepts on Information System and we present a survey of theories on which we have developed our constructs, chapter 3 presents the research model conceptualised on the reviewed literature, chapter 4 presents a high level view of BLIS architecture as well as, user interface, presentation interface, test bed and case studies. In chapter 5 we discuss results obtained by using BLIS for student individual assessment and we conclude on findings and future work in chapter 6.

2. Basic Concepts on Information Systems and Brain Lateralisation Theory

A computer based information system (CBIS) is a technologically implemented medium for recording, storing, and disseminating linguistic expressions, as well as for drawing conclusions from such expressions (Langefors, 1973). The high level functions of an Information System are presented in figure 1.

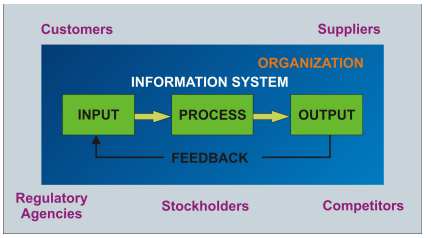

Figure 1. High level functions of an IS

The *Input* function refers to the capture or collection of raw data from within the organisation or from its external environment for processing in CBIS. The *Output* function represents the distribution of processed information to the people who will use it or to the activities for which it will be used. The *Processing* function deals with the conversion, manipulation, and analysis of raw input into a form that is more meaningful. The *Feedback* function is an output that is returned to the appropriate members of the organisation to help them evaluate or correct input.

The brain lateralisation theory developed by Roger Sperry and Robert Ornstein helps us to understand our behaviour, our personality, our creativity and our ability to use the proper mode of thinking when performing particular tasks. Sperry drew attention to the fact that these findings have a far-reaching effect on education – as the educational system discriminates against the right brain hemisphere, i.e. the non-verbal, non-mathematical, and spatial mode of apprehension and reasoning. Perceptual learning and memory seem to proceed independently in the two hemispheres of the brain. This only encourages educators to find ways to cater for both sides of the brain.

Ned Herrmann, the creator of the HBDI (Herrmann Brain Dominance Instrument) drew further attention on the theory of brain lateralisation. His four quadrant brain dominance model may be understood as a combination of left brain vs. right brain and triune brain concepts into a physiologically based metaphor of the human brain functioning. The model consists of four separate quadrants, A, B, C, and D. There is the logical, analytic, quantitative, fact-based A quadrant, metaphorically representing the left hemisphere of the cerebral cortex and similarly there is the planned, organized, detailed, sequential quadrant B, representing the left half of the limbic system. These two together represent the left mode thinking processes. The other two quadrants represent, on the one hand, the emotional, interpersonal, feeling-based, and kinaesthetic aspects of the C quadrant metaphorically located in the right half of the limbic system, and the fourth quadrant D, which represents the holistic, intuitive, synthesizing, and integrating modes of thinking, is based on the right cerebral brain (Herrmann, 1995).The model provides further insights into a possible classification of brain functions, starting from the theory of brain lateralisation.

In our research we conceptualised an IS that can provide valuable information on user's brain lateralisation and further on its thinking style. Such information can be used by educators in designing new teaching methodologies that will finally lead to adapted, personalised study programmes within the university curricula.

3. Research model

Our research is based on the established premise that the brain is made of two hemispheres that perform different functions, which can work together or separately: the left side of the brain, concerned with logical, analytical, verbal, numerical, judgemental tasks; and the right side of the brain, concerned with the creative, intuitive, whole-

concept, visual aspects of human thinking. The research model of the Brain Lateralisation Information System (BLIS) framework suggests that Student Individual Assessment, Adapted Teaching Methodologies and Learning Environment have significant influence on the elaboration of Personalised Education Programmes, as shown in figure 2. We conceptualized the design of the Personalised Education Programmes by using BLIS framework's main constructs: System characteristics (SC), Student Autonomy (SA), Organisational Factors (OF), Student Individual Assessment (SIA), its Controls (C) and Adapted Teaching Methodologies (ATM).
BLIS can be used even when traditional forms of evaluation are not available. If this form of evaluation is used for SIA, users should be able to find solutions to their problems quicker. As a result, the usage of BLIS is supposed to offer students a high level of flexibility in evaluation.

In our study, content feature is defined as part of the system characteristics and it is essential in the presentation of BLIS information in user friendly and ease to manage interfaces.

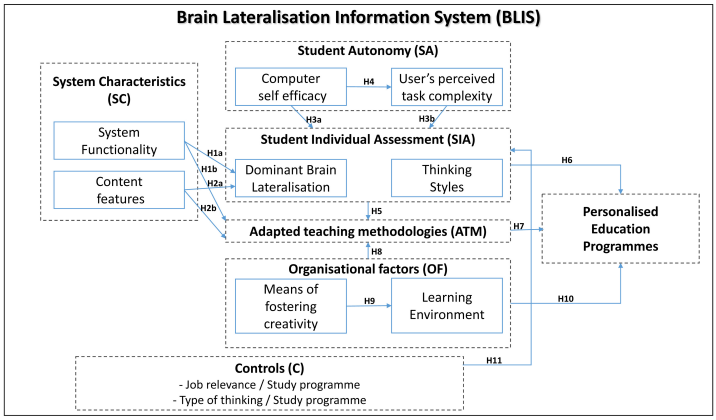

Figure 2. Research model of BLIS framework

Based on the reviewed theory (Sperry, 1974), (Herrmann, 1995) we have established that creative design and problem-solving are right-brain activities that the engineer shares with the artist, whereas applied design, project organization, materials assessment, and research are left-brain activities. From the point of view of teachers who want to stimulate creativity and develop all-round, comprehensive minds, one needs to try and use methodologies that will elicit as much material from students' creative side as possible before engaging the left side, since once you engage the judge in your mind, the flow of new ideas will be hindered. Researchers have emphasis on the fact that technology is advancing our society at an unprecedented rate and creative problem solving will be needed to cope with new challenges as they arise (Robinson, Azzam, 2009). To promote creative thinking educators need to identify what motivates their students and structure teaching around it. Providing students with a choice of activities to complete allows them to become more intrinsically motivated and therefore creative in completing the tasks (Robinson, 2009). High levels of adapted teaching methodologies focused on development of student's creativity are seen as a prerequisite for enhanced personalised study programmes. A positive learning climate encourages and stimulates the exchange of ideas, opinions, information and knowledge in the university as it is characterized by trust and collaboration between learners (Prieto and Revilla, 2006).

In order to introduce a feed back on the individual student assessment and the chosen of the attended curricula we have designed two control variables to ensure reliability of results. On the one hand, we control for job relevance and the chosen study programme. Additionally, we also control the type of thinking and the chosen study programme. Such controls may lead to corrections of the decision process within the student's self evaluation and further on may positively influence the development of the personalised study programme. True personalisation of study programmes requires a major shift in focus from an institution/teacher-centred approach to an authentic, student-centred approach. True personalisation provides a learning program and approach specifically tailored to the abilities, interests, preferences, and other needs of the individual student. Not in the last place, student's type of thinking has to be taken into consideration when personalisation of education programmes is discussed.

4. System architecture

BLIS is built on a three-tier model, in which the queries are sent to an intermediate level (application server), which returns the Structured Query Language SQL request to the database server. The database server processes the request and sends the result to the middle tier, which forwards it to the user. Java Server Pages were developed using Tomcat web server, and as application server, we also used Apache Tomcat.

BLIS has a login page with identification and password. The page that opens after authentication contains a menu offering the student the possibility of choosing the form to be filled or the report to be viewed. The developed system allows the access of each student to his specific resources, depending on the identity and the access rights. The questionnaire fill module contains two questionnaires, namely: Right Brain / Left Brain Quiz and Brain Dominance and Thinking Styles Inventory Test. Further on, we present the results obtained by respondent with id=1

The conclusion that the respondent with id=1 has the left brain hemisphere as dominant hemisphere is finally made according to the second report generated.

We have established the universe of thinking styles for each student (table 1) based on Hermann's theory on brain lateralisation (Herrmann, 1995).

Table 1. The universe of thinking styles

A Logical, Quantitative, Critical, Analytical, Factual	**B** Conceptual, Synthesising, Metaphoric, Integrative, Visual
D Sequential, Conservative, Controlled, Structural, Detailed	**C** Emotional, Humanistic, Expressive, Sensory, Musical

The total score obtained for each brain mode and the thinking style for the student with id=1 is presented in figure 6:

Knowing that A and D primarily represent the left-brain mode, while B and C primarily represent the right-brain mode, and that the highest score indicates the strongest thinking style, while the next highest is the secondary preference, we have disclosed the career choices for the responded having the id=1

5. Results and discussion

Data obtained was relevant as to students' dominant brain hemisphere and related processes (verbal vs. non-verbal processing; logical vs. intuitive, etc.). According to findings, students were then grouped so as to their needs in terms of pedagogical approach and teaching methodologies.

The second questionnaire available through BLIS (Brain Dominance and Thinking Styles Inventory Test), was applied to 59 out of the 70 students of Computer Science (39 male, 20 female). The results obtained were highly indicative of the fact that the majority were not actually suited to their prospective career. In terms of brain dominance, specialists in Computer Science should ideally display a combination between both left and right lateralisation, more specifically they should be able to carry out logical, rational, analytical mental processes, while at the same time they would also need to be able to conceptualise, synthesise, understand metaphorical language and visually apprehend reality. Only 43% were actually proved as suited for a career in R&D, MIS/ Data processing, Engineering, or Inventing, Research science.

A large percentage of respondents would be more suited for Business studies (Marketing/Management, Office management), Production and Planning, or even for Social studies (Occupational theory) or Services.

6. Conclusions

An individualized and student centred educational route needs to be designed for all engineering students, whose creativity may be fostered across the curriculum, through adequate teaching methodologies. The most important educational benefit is that of empowering students to take control of their own learning processes. The BLIS system allows students to understand their own thinking patterns and styles, while at the same time raising their awareness to their career suitability. The fact that their seem not to have made the right decision as to their professional future, it is possible for them to understand that they might be more suited, for example in the sales department of an IT company, or they might choose to work as web designers for a marketing company. As for the teachers, they might adapt the curricula in order to address the needs of the students, and in particular to help more students understand the thinking processes involved in the field of Computer Science. The questionnaires also revealed that few students

have actually developed their study and research skills, which are essential in Computer Science. It might therefore be useful to introduce a course component in the Research Methodology for Computer Science in the academic curriculum.

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